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9. ABSTRACT (Continue on reverse if necessary and identify by block number) Team communication patterns on the Team Resource Allocation Problem (TRAP) were evaluated to determine characteristics of leaders and elements of effective team performance. Talking frequencies and durations and types of verbalizations (commands, suggestions, etc.) of team members during TRAP performances were used as indices of leadership. Individual background information and task/setting features were assessed to see how they relate to leadership behavior. Team characteristics and communication patterns were related to team performance scores under high and low time pressure to evaluate team effectiveness. Results indicated that teams with computer-experienced members and teams which were given strategies for doing the task performed better. Older people, people with computer experience, and men emerged as leaders in giving suggestions and issuing commands. <i>Keywords:</i>						
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Preface

This research was conducted at the Harry G. Armstrong Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio, under the auspices of the Command, Communication, and Control Operator Performance Engineering (COPE) program. The first author was on a UES-AFOSR Summer Faculty Research appointment at the time.

We are indebted to Maj. D. J. McBride for allowing us to use data she had been collecting with her dissertation study in this project. Curtis Mayrand and Greg Bothe of SRL have been extremely helpful in conducting this research. Tracy Vogler was very efficient in organizing the data for analysis and in organizing and executing the coding of audiotape information. He and Rob Lindner, Greg Peyton, and Skip Shattuck of SRL deserve special thanks for their long hours of coding data.

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Emergent Leadership and Team Effectiveness on a Team Resource Allocation Task

Emergent leadership and team effectiveness are important considerations in the study of group tasks requiring coordination among members. By emergent leadership, we are referring to the extent to which a particular individual exhibited influential or leaderly behavior. Specifically, these leaderly behaviors are extent of verbal participation by the individual and the kinds of verbalizations made. We tried to discover features of individuals and teams which allowed these individuals to influence team outcomes. By team effectiveness, we are referring to team performance scores on an objectively quantified task. We tried to discover factors in the team's individual characteristics, composition, and communication patterns which contribute to good performance.

Emergent Leadership

Verbal participation has been demonstrated to be a very good index of influence and leadership (Sorrentino & Boutillier, 1975; Stein & Heller, 1979; Strickland, Guild, Barefoot, & Paterson, 1978). Another index of leadership is the number of directive comments made by the individual (Bales & Strodtbeck, 1958; Sorrentino & Field, 1986). We used both of these indicators to study emergent leadership in these investigations.

Leaders are more likely to emerge on certain types of tasks and in certain groups than others. Large groups need leaders more than small ones do (Hemphill, 1952). Members usually respond positively to emerging leaders when 1) they feel that they can succeed, 2) they value the rewards for success, 3) coordinated group effort is required rather than individual effort, and 4) the emerging leader is experienced at leading (Hemphill, 1961). Members are likely to appreciate and encourage an emerging leader when the group or team has experienced stress (Hamblin, 1958).

Under other circumstances, it is unlikely that an emerging leader will be encouraged by other members (Kerr & Jermier, 1978). If the team members have considerable and equal ability and experience, if they need independence, and if they are indifferent toward group rewards, anyone emerging as a task-oriented leader will be discouraged. If the task is unambiguous and routine, if it has little variability, and if it provides its own accomplishment feedback, task-oriented leaders will also be discouraged because their roles are minimized in importance by the nature of the task.

Let us consider some of the team and task characteristics in light of these variables. The teams observed were three-person teams composed of the various possible combinations of males and females. They had equal and identical roles in performing the task, which should have discouraged leadership dominance by one member. The small size of the teams should have worked against the emergence of leaders (Hemphill, 1952). The team members appeared motivated to succeed and to feel that they could succeed which should foster the emergence

of leaders. Team members had equivalent training and experience on this task, but they had different levels of experience with computers and video games. This differential experience should have encouraged the more experienced members to become leaders.

A potentially important factor in the emergence of leadership was the sex composition of the teams (Hollander & Yoder, 1980). Several studies have shown that men tend to be more task-oriented and women, more group harmony-oriented in groups (Bond & Vinacke, 1961; Eskilson & Wiley, 1976; Strodtbeck & Mann, 1956; Vinacke, 1969). Since we have focused on task-oriented leadership rather than socioemotional leadership (Bales & Slater, 1955) and since task-oriented behavior is more likely to occur during the trials (when we recorded interactions), we expected that men would emerge as leaders more than women. Males would emerge as leaders more if the task were a male sex-typed one, with which males would be expected to be more familiar (Hollander & Yoder, 1980). However, the TRAP task is probably only slightly sex-typed; that is, it is sex-typed to the extent that males spend more time on related instruments like computers and video games.

However, the sex composition of the team may have greater impact than the gender of the individual team member. For instance, Eskilson & Wiley (1976) found that male leaders performed more leaderly behavior when they led an all-male team than when they led a mixed-sex team. From these results, we expected that men and women team members would be more likely to emerge as leaders if they were in the majority than if they were the solitary male or female team member.

Self-attention theory (Mullen, 1983) suggests that sex composition would have other effects on behavior in the group. Mullen argues that self-attention makes a person try to conform to appropriate standards of conduct for him or her in the situation. He further states that an individual is likely to be more self-attentive in a group if his or her particular subgroup is small relative to the total number of people present. One basis for self- and other-group definition is gender (Mullen, 1983). Accordingly, a solitary male or a solitary female should be much more self-attentive than anyone in an all-male or an all-female group. If the normative standard for males in groups is to be more task-oriented and the standard for females is to be more group-oriented, then self-attentive solitary males should emerge as task-oriented leaders more than any other individuals. This prediction is opposed to the expectation expressed in the preceding paragraph. This position did lead us to expect that members of all-male or all-female teams would be less likely to emerge as leaders than members of the majority sex in mixed-sex teams would.

Task features should also affect the emergence of leaders. The Team Resource Allocation Problem (TRAP) task will be described in a later section. There was more time pressure on some trials than on others. Leadership behavior should have been encouraged more on fast trials (Hamblin, 1958). The large amount of team effort required should have encouraged task-oriented leadership. In the McBride (in preparation) study, half of the teams were given appropriate resource allocation strategies to use before they began. Those teams which received this heuristic information should have exhibited less leadership behavior

because the knowledge of appropriate strategies should serve as a substitute for leadership (Gleason, Seaman, & Hollander, 1978; Kerr & Jermier, 1978). In all conditions, performance feedback supplied by the apparatus should have also substituted for leadership. As the teams worked at the task, it became more routine. Therefore, less leaderly behavior should have been exhibited in the last session than in the first one.

Other task features could have affected the emergence of leadership. In all conditions of both studies, team members had to look at their displays continuously for information. The fact that all team members had access to identical information on the screens probably minimized leadership communication. The display screens also made verbal communication less necessary because a person could lead by moving his or her cursor to the desired line rather than talking about it. This leadership behavior, which we could not assess, probably occurred more in later sessions after all team members were familiar with the system. To the extent that members led by moving the cursor, lower verbal participation leadership would occur.

The required attention to the display screen reduced nonverbal communication channels in all conditions of both studies. In the isolated setting of the Wilson, McNeese, & Brown (1987) study, nonverbal communication was effectively eliminated. One would expect that verbal communication would be accentuated in the isolated setting to compensate for the unavailability of nonverbal communication. So greater team talking frequencies and average durations would be expected in that condition.

Team Effectiveness

We measured team effectiveness by deriving a team performance score on each trial. We attempted to see what information about team behavior and team characteristics predicted those scores best. The questions we asked were: Did teams with one dominant individual in terms of talking frequency or duration or number of commands issued perform better or worse than teams without a dominant leader? Did teams which talked more perform better or worse than less talkative teams? Did teams with much computer and/or video game experience perform better than inexperienced teams? Did teams with particular sex compositions perform better than other teams?

From the evidence that teams with members of essentially equal ability who perform identical roles discourage emergent leadership (Kerr & Jermier, 1978), we expected that teams with a dominant individual would perform worse. We expected that teams which talked more overall would perform better, especially when the team had not received strategy information beforehand and especially in the first session. However, a study of teamwork in naval crews indicated that verbal communications, when they are unnecessary, have a disruptive effect on performance (Williges, Johnston, & Briggs, 1966). On the present task, some verbal communication seems to be necessary to coordinate the team's efforts optimally. Hence our prediction that talking will enhance performance stands.

Further, we expected that the team characteristic of having team members

who were experienced with computers and video games would yield better team performance. This experience may have been extremely helpful on faster trials. If there were different levels of experience within the same team, teams in which the most experienced person(s) talked most should have performed better. The sex composition variable was expected to affect team performance in the following way: Mixed-sex teams, especially male majority teams, were expected to perform better because appropriate leaders should emerge and group harmony needs, which appear to be important to team functioning, should be met with the presence of at least one female.

Types of Verbalizations

The audiotaped information in the McBride study was analysed according to different types of verbalizations. Research cited by Foushee (1981) on communications between flight crew members has interesting implications for our coded data. He stated that more errors were made by crews who communicated very little. That result suggests that total verbalisation scores should be positively correlated with performance scores. Further, he stated that more acknowledgements to statements was associated with fewer errors. These results led us to expect that more agreeing responses would be associated with better scores. More commands were also associated with fewer errors, which led us to expect that more commands would be associated with better performance. An unsubstantiated comment by Foushee suggests that the use of suggestions or questions to initiate actions instead of direct commands may contribute to better performance. Also, if one person issues more commands than others, it may lead to poorer performance in this equal status team situation. More time pressure (on fast trials) should lead to more emergent leadership in terms of number of commands issued. We also expect that fewer commands would be issued in later sessions, on slow trials, and among teams given heuristic information because of the lowered need for leadership (Kerr & Jermier, 1978).

Team members with more video game and computer experience were expected to exert leadership by issuing more commands or suggestions. Positions cited earlier indicating that women are more group-harmony oriented than men and some of Foushee's (1981) observations led us to expect that women would be likely to make less commands, more suggestions, more questions, and more agreeing responses than men would.

The TRAP Task

The Team Resource Allocation Problem (TRAP), the task used in both studies that we analyzed, was developed by Cliff Brown (Brown & Leupp, 1985). It is a task which requires that team members coordinate their efforts to maximize their team score. In the graphic display mode, targets appear on the screen and move from left to right. There are eleven rows on the screen and, at a particular time, there are targets on most of the rows. Some targets require all three team

members to use their cursors to be on the same row simultaneously. Others require two team members and others, one. The way the targets are staggered across the screen, it is impossible to respond to all targets during the time they are on the screen. As you can see in the table below from Wilson, McNeese, and Brown (1987), targets on the screen which require all three members to respond are worth more than two-person targets and one-person targets.

Table 1. Target Values

One Person Targets		Point Value
Blue triangle		1
Red triangle		3
Blue circle		3
Red circle		5
Two Person Targets		
Blue triangle		4
Blue circle		4
Red triangle		8
Red circle		8
Three Person Targets		
Blue circle		3
Red circle		9
Blue triangle		9
Red triangle		15

The task is to accumulate as many points as possible on a trial. Figure 1 from Wilson, McNeese, and Brown (1987) illustrates how the screen could look at one time on a trial. There are other variations of the task which were used in the two studies from which we analyzed data. One variation in the study by Wilson, McNeese, and Brown (1987) was to present an equivalent alphanumeric version of the graphic display (i.e. 11 labels such as "blue triangle" with a clock ticking off the time rather than having targets moving across the screen). The McBride (in preparation) study used the original graphic display and three other moving target displays: 1) letter target, 2) color targets, and 3) letter / color targets.

An important addition to all displays in the McBride study was 20 black rectangular targets of uncertain value. To find out an uncertain target's potential value, all three members had to cursor to the row and press "start". After a time, the potential points and the probability of getting the points appeared on the rectangle; for example, L84 meant that there was a low probability (20%) of getting 84 points. At that point, the team could abandon that target for other opportunities or press "start" to commit to that target.

ROW	A	B	C	TARGET	TIME	STATUS
1				RED CIRCLE	24	WORK
2				BLUE TRIANGLE	18	
3						
4				RED CIRCLE	7	
5				RED TRIANGLE	2	
6				BLUE TRIANGLE	15	
7				BLUE TRIANGLE	5	WORK
8				BLUE TRIANGLE	25	
9				RED TRIANGLE	20	
10				BLUE CIRCLE	13	
11				RED CIRCLE	29	
A B C						
				FREE	ACCUMULATED POINTS 35	
				WAIT		
	9	9	3	WORK		

ROW	A	B	C	OPPORTUNITY WINDOW
1				○
2				△
3				
4				○
5				△
6				△
7				△
8				△
9				△
10				○
11				○
A B C				
				FREE
				WAIT
	9	9	3	WORK
				ACCUMULATED POINTS 35

Figure 1: AlphaNumeric Display (top) Graphic Display (Bottom)

Method

We analyzed computerized data from the Wilson, McNeese, and Brown (1987) study, and computerized and audiotaped information from the McBride (in preparation) study. The primary independent variables in the totally within-teams design of the Wilson et al. study were: 1) display speed (fast & slow); 2) setting (large screen display and small screen with isolated team members) and 3) display format (alphanumeric and graphic). The effects of these variables on team performance is presented in that paper. The primary independent variables of the McBride study were: 1) display speed (fast and slow); 2) display format (original graphic, color, letter, & letter/color); and 3) heuristics (possible strategies presented or not). It should also be noted that uncertain targets were a constant in the McBride study, while they did not appear at all in the Wilson et al. study. The twenty additional uncertain value targets added approximately one minute to the fast trials and two minutes to the slow trials. The effects of these variables on team performance will be presented elsewhere.

Subjects

Sixteen three-person teams participated in the Wilson et al. study, and 32 three-person teams participated in the McBride study. The sex composition of the teams varied from all male to all female. All individual background information available was used in the analysis. This included the sex composition of the teams, the seat location of members, and in the McBride study, the class of team members (and age of approximately half the teams), and computer and video game experience from self-reports.

Procedure

Information on experimental conditions, average talking duration per individual per trial, talking frequency per individual per trial, and team performance score per trial was derived from computer records for the two experiments. Other individual information and sex composition of the team were combined with that data from both experiments.

We also analysed audiotape information from the McBride study. Coders listened to one or two channels of the audiotapes corresponding to utterances of one or two team members during the trials of the first and last sessions. For each utterance, the coder recorded the person speaking (A, B, C) and classified the verbal content as 1) a command, 2) a suggestion, 3) a question, 4) a statement, 5) an agreeing response, or 6) a disagreeing response. From this raw data, we derived the number of each type of verbalization by each person on each trial. This information and the talking frequencies and durations were used to assess the amount of influential or leaderly behavior by each individual.

Subjective estimates of the percent influence of each team member on target

decisions were also obtained from each subject.

Derived Scores. Some of the measures used were the same across the two studies. In both studies, the primary measures of team participation were total team talking frequency per four minutes of trial time (FREQ); average utterance duration for the team (DUR); the maximum frequency of the team (MAXFREQ), which represented the percent of talking frequency for the most talkative member of the team; the maximum duration of the team (MAXDUR), which represented the percent of the team's talking duration of the longest talking member; the standard deviation of the frequencies of the team (STDFREQ); and the standard deviation of the durations for the team (STDDUR). These team behavior measures were compared to team performance scores (SCORE), which were expressed as a percentage of optimal scores predicted by a model for each trial, to assess team effectiveness. The individual participation measures used to index leaderly behavior were standardized frequency (ZFREQ), which was the number of times a person talked relative to the talking frequency of the whole team; the raw individual frequency (IND FREQ); and individual duration (IND DUR), which was the team member's average utterance duration.

In the Wilson et al. study, sex of the team member (in particular sex composition teams), the seating position, and SWAT preference scores were related to these individual behavior measures. The sex composition of the teams was related to the team behavior measures and the team score.

In the McBride study, the age, academic class, member sex in particular sex composition teams, individual computer experience scores (from self-report), individual video game experience, and influence (mean of subjective ratings of percent influence) were related to the individual behavior measures. The sex composition of the team, team computer experience, team video game experience, and team maximum influence (which was the influence score of the most influential member of the team) were related to the team behavior measures and the team performance scores.

The audiotape data from the McBride study was coded into commands, suggestions, questions, task-related statements, agreeing responses, and disagreeing responses made by Person A, B, and C on each trial of the first and fourth (last) session. The frequencies of these six response categories comprised the individual leaderly comments measures; they were related to the same individual factors mentioned in the preceding paragraph. Two individual measures, COUNT and ZCOUNT, were derived for each category and a total communications category. COUNT referred to the raw number of such comments made by the individual; ZCOUNT was the number of such comments relative to the total of the comments made by the whole team. Maximum scores on each category (MAXCOM, MAXSUG, MAXQUEST, MAXSTATE, MAXYES, MAXNO and MAXTOTAL), which represented the number of such comments made by the person who issued the most commands, etc. relative to the team total for the category, were derived. SCOUNT was the sum of the verbal category for a team. These leadership and team behavior measures were related to each other and the team

performance score.

Results

Wilson, McNeese & Brown Results

At the team level, trial speed (involving time pressure) had some interesting effects on behavior. Teams talked more times per minute on the fast trials, $F(1, 15) = 9.17, p < .01$; and they talked in shorter utterances on the fast trials, $F(1, 15) = 12.13, p < .005$. Also, a talking leader emerged most on the fast trials with graphic displays, $F(1, 15) = 3.88, p < .07$; and the variation in talking frequency among team members was greatest on the fast trials, $F(1, 15) = 6.28, p < .05$. As for team performance, teams scored better on the slow trials than on the fast trials, $F(1, 15) = 188.19, p < .0001$; and they scored better with graphic displays than with alphanumeric displays, $F(1, 15) = 23.35, p < .0002$. The group versus isolated setting did not affect performance or behavior. Nor did the sex composition of the teams affect behavior or performance of the team as a whole.

When behavior at the team level was correlated with team performance, an interesting pattern appeared. The teams who had more dominant talking leaders scored worse, $r(16) = -.50, p < .05$ between MAXFREQ and SCORE. When the experimental conditions were ignored, the correlation between team talking duration and team performance was significant, $r(128) = .22, p < .02$, indicating that teams which talked in longer utterances scored better.

In this study, we only had three individual factors to examine to see which kinds of people exhibited the most leaderly behavior. Those three factors were sex of the individual (within particular sex composition teams), individual SWAT preferences, and individual seat position. The overall Fs of sex composition did not approach significance for any of the measures. But according to pairwise comparisons, the solitary women in majority male teams talked more than women in majority female teams ($p < .06$) in terms of individual talking frequencies; and in terms of standardized frequencies (ZFREQ) and durations, they talked more and in longer utterances than men in those majority male teams ($p < .07$ for both measures). For the SWAT preference types, we only used the data from the four teams who had a team member of each SWAT type for analysis; and the overall ANOVA results were not significant, $F(2, 9) = 2.63, p < .13$. However, pairwise comparisons showed that subjects who focused on cognitive effort in their subjective workload judgments talked more than team members who emphasized psychological stress in their workload judgments ($p < .05$). Seat position did not affect the amount of leaderly behavior displayed.

The McBride Computerized Data Results

The effects of trial speed on team performance and behavior in this study were very consistent with the results in the Wilson et al. study. Again, teams talked more times per minute on the fast trials, $F(1, 24) = 61.70, p < .0001$; and they talked in shorter utterances on the fast trials, $F(1, 24) = 24.24, p < .0001$. Also as in the Wilson et al. study, teams scored better on the slow trials than on the fast trials, $F(1, 24) = 470.53, p < .0001$. As in the earlier study, variation in talking frequency was greater on the fast trials, $F(1, 24) = 10.11, p < .005$.

The sex composition of the teams did not affect behavior or performance according to the overall F 's, but pairwise comparisons suggested that variances in talking frequency (STDFREQ $p < .07$) and duration (STDDUR $p < .05$) were greater in majority male teams than in majority female teams. Also, among teams which were not given heuristics, all male and majority male teams performed better than majority female teams, $F(2, 13) = 3.75, p < .052$.

Other factors present only in the McBride study affected team performance and behavior. Teams that received heuristics about the task performed better than teams who did not, $F(1, 24) = 13.67, p < .005$, with the best scores being achieved by teams with heuristics on the fast trials, Interaction $F(1, 24) = 8.28, p < .01$. Teams given heuristics also talked in longer utterances, $F(1, 24) = 6.42, p < .02$; and on the fast trials, these teams with heuristics spoke more than teams in the other three conditions. Interaction $F(1, 24) = 7.01, p < .02$. In addition, variability in talking frequency was greatest among teams given heuristics on fast trials, STDFREQ Interaction $F(1, 24) = 12.84, p < .005$.

The statistics on sessions revealed some interesting patterns of behavior as the teams became more experienced at the task. Teams scored better in the final two sessions than in the first one, $F(3, 72) = 10.11, p < .0001$; and they talked less, $F(3, 72) = 4.26, p < .01$. Also, leaderly talking behavior increased from the early sessions to the later ones: MAXFREQ $F(3, 72) = 3.99, p < .011$ and MAXDUR $F(3, 72) = 3.69, p < .02$; and the variability in talking frequency and duration increased from the early sessions to the later ones. STDFREQ $F(3, 72) = 9.79, p < .0001$ and STDDUR $F(3, 72) = 9.26, p < .0001$.

When behavior at the team level was correlated with team performance, the negative correlation between dominance of the talking leader on the team and score was not significant, $r(32) = -.15, p = .41$; unlike in the previous study. Results indicated that overall team computer use experience was related to team performance, $r(32) = .54, p < .002$.

At the team level, partial correlations between behavioral measures and score (adjusted for teams, meaning that teams' intercepts were equated) at different levels of heuristics, sessions, and trial speeds were calculated. Most significant correlations occurred in the first session on fast trials with the teams which were given heuristics. Under those conditions, teams which talked less scored better, $r(64) = -.30, p < .05$; and teams with more dominant talking leaders and greater variability in team members' talking scored better, r 's between score and MAXFREQ, MAXDUR, STDFREQ, and STDDUR ranged from .30 to .35, p 's $< .05$. By the last session and for the slow trials throughout, these

correlations disappeared for the teams with heuristics. The only significant partial correlation for the teams which were not given heuristics occurred in the first session on the slow trials. This result indicated that teams which talked in longer utterances under these conditions scored better, $r(64) = .31, p < .05$. No other partial correlations with team performance were significant.

On the individual level, we evaluated the relationships of academic class, age, sex (in particular sex composition groups), computer experience, and video game experience to talking leadership measures (frequency, standardized frequency, and average talking duration) and rated influence on the team's decisions. Among the individual background variables, males had more video game experience, $F(1, 94) = 14.20, p < .001$; as did lower academic classification subjects, $r(96) = -.20, p < .053$. Males also had slightly more computer experience, $F(1, 94) = 3.77, p < .06$. There were no differences in computer experience between subjects based on age or classification.

On the individual level, some interesting patterns emerged in the data on rated influence of the individuals. Recent video game players were rated as more influential than those who had not played recently, $r(48) = .28, p < .054$. Also, those who talked less, according to ZFREQ, were rated as more influential, $r(48) = -.27, p < .07$. Video game players talked less than non-players, $r(96) = -.21, p < .05$. To examine this pattern more closely, we broke rated influence down into rated influence on fast and slow trials, and we examined the correlations at different levels of heuristics and trial speed. It occurred that the strongest correlations with rated influence (on fast trials) appeared for the members of teams given heuristics on the fast trials. Under these conditions, persons who talked (ZFREQ) less were rated as more influential, $r(27) = -.36, p < .07$, and experienced video game players were rated as more influential, $r(27) = .39, p < .05$.

Sex of the individual did affect talking behavior in different sex composition teams. Pairwise comparisons on the frequency measure indicated that females in majority female teams ($M = 9.91$) talked more than females ($M = 4.19, p < .052$) or males ($M = 5.86, p < .02$) did in majority male teams. The average duration data revealed that females in a majority ($M = 4.41\text{sec.}$) talked more than males in a majority ($M = 3.30\text{sec.}, p < .03$). Also on the duration measure, males in all male teams ($M = 4.47$) talked in longer utterances than males in majority male teams ($M = 3.30, p < .005$).

Types of Verbalization: Analysis

Four coders recorded the six types of verbalizations spoken by the three members of the 32 teams during their first and last (fourth) sessions of eight trials. Because each team's sessions required two or three hours to code, each coder did approximately one-fourth of the coding of comments. All coders did one session of one team in order to check on the reliability of the coders. The pairwise reliability coefficients among three of the coders were .97, .93, and .94. However, partly because he coded what the other three coders had recorded as suggestions as commands, the correlations between the fourth coder's observa-

tions and those of the other three coders were .10, .08, and .29. The data from the teams he coded were eliminated from the analysis. In addition, data from nine teams which talked very infrequently were eliminated because we judged that their data would distort some of the percentage-wise or proportional results. Consequently, data from only 18 of the 32 teams were used in the analysis.

First, we examined the effects of heuristics, session, and trial speed on the team's verbalizations. As in the previous analyses, trial speed had powerful effects on team verbal behavior. Fast trials elicited more comments per time unit made by the whole team in the verbal categories of commands, $F(1, 16) = 20.47, p < .001$; suggestions, $F(1, 16) = 80.28, p < .0001$; agreeing responses, $F(1, 16) = 4.45, p < .051$; and disagreeing responses, $F(1, 16) = 7.50, p < .02$, than slow trials did. As would be expected, fast trials elicited more total team communications than slow ones did, $F(1, 16) = 69.93, p < .0001$.

Trial speed had different effects on how much one member dominated in giving suggestions and on how much one person disagreed more than the others. On slow trials, one person dominated in giving suggestions more than on fast trials, $F(1, 16) = 10.43, p < .01$. However, more domination by one person in disagreeing occurred on the fast trials than on slow ones, $F(1, 16) = 6.58, p < .05$.

Teams consistently made more commands, $F(1, 16) = 7.21, p < .02$; more task-related statements, $F(1, 16) = 4.14, p < .06$; and more agreeing responses, $F(1, 16) = 10.86, p < .005$; during the first session than during the last session. Total team communications followed the same pattern, $F(1, 16) = 7.78, p < .02$. A Trial Speed X Session interaction indicated that the decline in number of team commands from the first session to the last one was greater on the fast trials, $F(1, 16) = 10.90, p < .005$. There was an Heuristic X Session interaction on MAXNO, the leadership measure for disagreeing responses, $F(1, 16) = 4.25, p < .056$; indicating that dominance in disagreement decreased from the first to the last session on teams without heuristics but increased for teams given heuristics.

There were no significant correlations between team scores and the team amount or leadership measures for any of the verbal categories overall. It is interesting to note, however, that team members did fit into different roles. That is, the person who emitted the most of each type of verbalization gave significantly more than 33.3% of those responses. The foremost contributors of commands gave 68.1% of the team's commands; suggestions, 52.6%; questions, 64.8%; task-relevant statements, 52.1%; questions, 64.8%; agreements, 62.6%; and disagreements, 71.3%. But those who gave the most commands, suggestions, and disagreements to direct or redirect actions must not have been the most talented at the game because leadership on these categories was uncorrelated with team scores. Suggestions were the most common type of verbalization ($n = 16.0$ per team per 4 minutes of trial time); disagreeing responses were the most uncommon ($n = 1.2$).

When team measures were broken down according to heuristics, session, and trial speed, there was only one correlation that was high enough to be considered meaningful in light of the number of correlations which were computed. That correlation, $r(6) = .96, p < .003$, indicated that the more disagreements that occurred on slow trials in the last session among teams not given heuristics, the

better the team's score was.

The only discernible effect sex composition of the team had on overall team behavior occurred in the statements category. Male majority teams had one member who dominated in making task-relevant statements more than female majority teams did. Male majority MAXSTATE $M = 59.81$, Female majority MAXSTATE $M = 48.48$, $p < .05$ by pairwise comparison.

On an individual level, correlational analyses indicated that several verbal categories were related to the rated influence of the individual on the team's decisions. Relative to others on their teams, those who issued more commands, $r(30) = .40$, $p < .05$; those who made more suggestions, $r(30) = .61$, $p < .001$; those who made more disagreeing responses, $r(30) = .52$, $p < .005$; and those who made more total comments, $r(30) = .75$, $p < .0001$, were rated more influential. Making suggestions was most strongly related to influence.

Some individual characteristics were related to the number and types of comments made. Older people made more suggestions, $r(30) = .42$, $p < .02$; made more agreeing, $r(30) = .61$, $p < .001$, and disagreeing responses, $r(30) = .45$, $p < .02$; and made more total task-related comments, $r(30) = .50$, $p < .005$, than younger people did. Also, individuals who had more computer experience made more suggestions than computer-inexperienced people did, $r(54) = .33$, $p < .02$. A similar pattern appeared for video game players, $r(54) = .26$, $p < .061$.

When we examined the verbalizations of men and women, we found that women asked more questions than men did, $F(1, 52) = 7.39$, $p < .01$. Relative to other team members, men made more task-relevant statements than women did, $F(1, 28) = 18.67$, $p < .001$; and men made more suggestions than women did, $F(1, 28) = 5.85$, $p < .05$. When the verbalizations of men and women were considered in the context of different sex composition teams, similar results were obtained. For instance, women in female majority teams asked more questions than people in any of the other teams did, $F(4, 49) = 2.70$, $p < .05$. Relative to other team members, men in majority male and majority female teams made more task-relevant statements than women in majority male and majority female teams did, $F(3, 26) = 7.05$, $p < .005$. Also, although the overall F test was not significant, pairwise comparisons showed that men in majority male teams made more suggestions than women in the same teams: male ZCOUNT $M = .46$, female ZCOUNT $M = -.92$, $p < .05$. On the other verbal categories, no sex differences occurred.

Discussion

What type of person is most likely to lead in such tasks? Which kinds of teams perform better? Which task features affect behavior and performance? How is communication involved?

Leadership

From the Wilson et al. study, verbal participation or talking time was our index to leadership. From that data, it appears that the only woman in a male majority team is likely to lead. That finding is consistent with self-attention theory (Mullen, 1983), which indicates that individuals in a minority are more self-focused and are more likely to try to perform well. People who are attuned to the mental concentration demands of a task are more likely to lead than those who focus on the psychologically stressful aspects of the task are. Both of these results are quite tenuous statistically.

The effects of sex and sex composition on talking leadership are muddled. In the McBride study, it was the women in female majority teams who talked more than the solitary woman in the male majority teams, which is a pattern opposite to the Wilson et al. results.

There is also reason to question whether simple amount of talking is a good index of leadership. In the second study, those who talked less were rated as more influential by fellow team members. The fact that video game players, who talked less, were rated as more influential also makes us question whether amount, rather than type, of verbalization is a good measure of leadership. The video game players' pattern of behavior suggests that they may have been leading by moving their cursor to the desired row rather than talking.

When we examined the types of verbalizations, we found that commands, suggestions, questions, agreeing responses, and disagreeing responses were all positively related to rated influence. On an a priori basis, we define commands, suggestions, and disagreeing responses as directive, leaderly behaviors. Viewed in this way, older people, people with more computer experience, and men acted in more leaderly ways. Women asked more questions, which might be construed as seeking leadership, than men did.

Team Effectiveness

Our index of team performance was the number of points scored by a team on a trial relative to a maximum score generated by a model. The first study indicated that teams that had a dominant talking leader scored worse, suggesting that more even participation by all members produces better performance on this type of task. Also, teams that talked in longer utterances performed better.

The second study showed that giving teams heuristic information about executing the task improved their performance. Teams also performed better in later sessions as they accrued experience on the task than they did in the first session. Teams performed better when the time pressure created by the speed of the moving targets was less.

But what team characteristics and ways of behaving affected performance? Those teams whose members had more computer experience scored better. For teams not given heuristic information, all male and majority male teams performed better. Perhaps these teams performed better because men had more computer and video game experience than women did. For teams with heuristics in the first session and on fast trials, teams that talked less scored better and those teams in which one person dominated talking and others fell quiet also scored better. In the analysis of types of verbalizations, there were no factors that generally affected team performance.

Task Features

Time pressure in performing the task affected team behavior and performance. Teams talked more per minute and in shorter utterances on fast trials when they had to hurry to handle the targets before they went off the screen. One person tended to dominate the talking on fast trials because there was no time for conversational turn-taking. Teams did not score as well on fast trials. Probably teams performed worse on the fast trials because of the speed of the targets, not because they talked more.

As the teams improved their scores in later sessions, they talked less with fewer commands, task-related statements, and agreeing responses being made. Also, one person dominated the talking more in later sessions than in the early sessions. It seems that they talked less because they got familiar with the task and communication became unnecessary rather than that they improved their performance because they talked less.

The Role of Communication

All team members worked on the same task with the same information on each screen. Everyone could see each other's cursor movements. Verbal communication would have been more necessary if they had not been able to see the other cursors. After a time, the task became routine and members became adept at responding by watching objects on the screen. Leadership communications were handled more and more by cursor movements.

Even with this reduced need for communication, team members did adopt different communication roles. One member became the leader by issuing directives by commands or suggestions more than the others did. Others simply agreed or made task-related but not directive statements or asked questions. That leadership was not positively related to performance probably occurred for several reasons. One reason was possibly that the most able members were

not the most assertive. There was very little disagreement on the task so whoever spoke up first took charge. We know that the experienced video players, who may have been most skilled, did not speak much.

Another factor may have been that verbal communication is quite time-consuming. That might explain why one person dominated talking on fast trials. In addition, visual communication was restricted by members' side by side seating and their need to watch the targets on the screen. Consequently, members would not have seen facial cues indicating that it was now their turn to speak. Coordination of speech was impaired. Aural communication was restricted by the headsets and microphones, which were a hindrance to natural conversation. Therefore, communication played a more minor role in this situation than in many others.

Conclusions

Older people, people with computer experience, and men emerged as leaders on this task. The teams which performed best were those whose members were computer-experienced and teams who had been given information on strategies for executing the task. Performance seemed to be hindered if a dominant talking leader emerged on this particular task.

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